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ABSTRACT

The influence of the first year of college on the development of critical thinking was assessed. Matched groups of students who attended and who did not attend college were compared on the Watson-Glaser Critical Thinking Appraisal over a 1 year period. Secondary school level of thinking and other covariates (e.g., aptitude, socioeconomic status, educational aspirations) were assessed. Students with 1 year of college had significantly higher total critical thinking scores and significantly higher scores on the interpretation and evaluation of arguments subscales. The advantages accruing to college attendance were modest. These effects appeared to be the same for all students, irrespective of individual differences in gender, race, and secondary school levels of critical thinking, aptitude, grades, socioeconomic status, and educational aspirations. Additional analyses suggests that net of the study covariates college selectivity, curricular emphasis, and individual measures of intellectual and social involvement during college had no significant associations with critical thinking. A composite measure of intellectual and social involvement during the freshman year did have positive partial correlations with critical thinking. Included are 34 references. (Author/SW)

The Development of Critical Thinking: Does College Make a Difference?

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Abstract

This study sought to assess the influence of the first year of college on the development of critical thinking. Matched groups of students who attended and who did not attend college were compared on the Watson-Glaser Critical Thinking Appraisal. Net of secondary school level of critical thinking and other covariates (e.g., aptitude, socioeconomic status, educational aspirations), students with one year of college had significantly higher total critical thinking scores and significantly higher scores on the interpretation and evaluation of arguments subscales. The advantages accruing to college attendance, however, were modest, ranging from 17.0% to 24.8%. These effects appeared to be the same for all students, irrespective of individual differences in gender, race, and secondary school levels of critical thinking, aptitude, grades, socioeconomic status, and educational aspirations. Additional analyses suggested that net of the study covariates college selectivity, curricular emphasis, and individual measures of intellectual and social involvement during college had no significant associations with critical thinking. A composite measure of intellectual and social involvement during the freshman year, however, did have positive partial correlations with critical thinking.

A considerable body of research has addressed the issue of the influence of college on student learning. (For recent reviews of this research see Bowen, 1977 and Pascarella, 1985). This research has suggested three general conclusions. First, students appear to make significant and substantial gains during college in standardized measures of specific content knowledge such as those developed by the American College Testing Program or the Educational Testing Service (e.g., Learned and Wood, 1938; Lenning, Munday and Maxey, 1969; Pace, 1979; Dumont and Troelstrup 1981). Second, individuals who attend college make significantly greater gains in such areas as vocabulary knowledge, mathematical skills, public affairs, history, science, and government than those whose formal education ends in secondary school. Moreover these gains remain even when differences in salient background characteristics (e.g., aptitude, social status) between college and non-college individuals are taken into account (e.g, Hyman, Wright and Reed, 1975; Wolfle, 1980; Owings and Fetters, 1983; Robertshaw and Wolfle, 1982; Wolfle, 1983). Third, net of variations in student precollege aptitudes and motivations, there is little consistent evidence to suggest that commonly accepted dimensions of "institutional quality," such as the academic selectivity of the student body, financial and educational resources (e.g., endowment or library size), or faculty "prestige" make an important incremental difference in how much students learn during college (e.g., Nichols, 1964; Astin, 1968; Rock, Centra and Linn, 1970; Centra and Rock, 1971; Ayres, 1983; Ayres and Bennett, 1983).

Beyond the simple acquisition of knowledge, however, a major aim of American higher education has been to enhance one's ability to think

critically, to reason, and to evaluate and weigh evidence judiciously in making decisions and choices among alternative courses of action (e.g., Dressel and Mayhew, 1954; Lehmann, 1963; Smith, 1977; Whitla, 1978; Young 1980; Mentkowski and Strait, 1983; National Institute of Education, 1984; McMillan, 1986). This cluster of intellectual skills has often been labeled "critical thinking ability," and it has equally as often been identified as one of the major outcomes of higher education. One needs only to peruse the recent catalogues or bulletins of undergraduate institutions to see "critical thinking," or a closely related term, used to define one of the primary objectives of the collegiate experience. Moreover, as pointed out by McMillan (1986), two recent influential national reports on the state of American higher education issued by the National Institute of Education (1984) and the Association of American Colleges (1985) have stressed the fostering of one's ability to think critically as one of the indispensible impacts of an undergraduate education.

Not surprisingly, the assessment of changes or growth in critical thinking during college has been the focus of considerable research. A recent comprehensive and carefully conducted synthesis of this research by McMillan (1986) reviews 27 studies. The results of this synthesis suggest two trends relative to the present study. First, it seems reasonably clear that students gain in their ability to reason critically during college. At the same time, however, in accounting for these gains it is extremely difficult, if not impossible, to separate the effects of college from those of student maturation. Second, nearly all inquiry on the effect of college on critical thinking estimates these effects with research designs which compare incoming

freshmen with end-of-freshman year students or upperclassmen. This is typically done in either of two ways: 1. longitudinal panel designs in which freshmen are compared with themselves at some subsequent time during college; or 2. cross-sectional cohort designs in which entering freshmen are compared with upperclassmen at the same time.

If used judiciously, such designs can provide useful information (Pascarella, 1987). Due, however, to the potential confounding influences of subject maturation in longitudinal panel studies and both maturation and differential subject recruitment and attrition effects in cross-sectional cohort studies (Pascarella, 1985), such designs are not the most powerful for directly estimating the influence of college attendance on critical thinking. This is better accomplished through the use of a naturally occuring control group of subjects who do not attend college. An extensive literature review, however, found no study which longitudinally compared the critical thinking development of college and non-college groups. Consequently, it is extremely difficult to estimate the magnitude of the unique or net influence of college attendance on critical thinking. The present study addressed this issue through a longitudinal study which compared matched groups of college and non-college students on changes in critical thinking over a one-year period.

Method

Sample and Instruments

The sample for the study was 47 high school seniors from five high schools in a large midwestern metropolitan area. The students were part of a larger sample of 70 seniors at the five high schools who, in addition to

taking the ACT in their senior year, also completed the Watson-Glaser Critical Thinking Appraisal (Form A) (Watson and Glaser, 1980) in April 1986.

The Watson-Glaser Critical Thinking Appraisal, Form A (hereafter refered to as the CTA) consists of a series of 80 objective items that include problems, statements, arguments, and interpretations of data similar to those encountered in daily life (McMillan, 1986). The instrument has five subtests designed to measure different, though related, aspects of critical thinking. These subtests include:

1. inference: discrimination among degrees of truth or falsity of inferences drawn from given data; (Each exercise begins with a statement that the individual is asked to regard as true. This is followed by a series of inferences which the individual decides are true, probably false, false, or insufficient data from which to form a judgment.);
2. recognition of assumptions: recognizing unstated assumptions or presuppositions in given statements or assertions; (Statements are followed by proposed assumptions, and the individual decides whether the assumptions are taken for granted in the statement or not.);
3. deduction: determining whether certain conclusions necessarily follow from information provided in given statements or premises; (The individual decides if a series of conclusions do or do not necessarily follow from statemetns that are to be regarded as true without exceptions.);
4. interpretation: weighing evidence and deciding if generalizations or conclusions based on the given data are warranted; (The method of

response is similar to that in deduction except that conclusions are to be based on information presented in short paragraph.); and

5. evaluation of arguments: distinguishing between arguments that are strong and relevant and those that are weak or irrelevant to a particular question; (A series of questions is followed by arguments, and the individual must decide whether each argument is strong or weak.)

The Watson-Glaser CTA yields a total score with internal consistency reliabilities in the .70 - .85 range, and test-retest reliabilities in the .70 - .75 range. It also yields five subscores with test-retest reliabilities rangining from .45 - .69. Subscores are weighted equally in deriving the total score (Watson and Glaser, 1980). The CTA is, by far, the most commonly used measure of critical thinking with the postsecondary student samples, being the instrument of choice in 16 of the 27 studies reviewed by McMillan (1986).

As suggested by McMillan's (1986) analysis, critical thinking as measured by the CTA is a very broad and general construct. Consequently, it is unlikely to be influenced by narrow or specific academic experiences such as a single course or teaching strategy. On the other hand, it is more likely to be sensitive to the impacts of broad-based educational experiences, such as exposure to postsecondary education. Since the major purpose of this study was to estimate the effects of the overall collegiate experience on critical thinking, the Watson-Glaser CTA was the instrument selected to measure the construct.

In addition to the Watson-Glaser CTA, a series of salient student background characteristics were also collected in May of 1986. These included the following:

1. combined American College Testing Program (ACT) scores: A measure of overall academic aptitude (obtained from secondary school records);
2. average secondary school grades: coded 1 = "D or less", to 7 ="A or A+";
3. family socioeconomic status (SES): average of parents' formal education (1 = "elementary school only," to 6 = Ph.D., M.D., J.D. or their equivalent) and combined yearly earnings. Since the two variables comprising this scale were on a different metric, they were each standarized before being summed;
4. educational aspirations: highest formal academic degree to which the student aspired; coded: 1 = "high school only", to 5 = Ph.D., M.D., J.D. or their equivalent.

Previous research on college impact has indicated that these variables are salient influences on both the student's college experience and the outcomes of that experience (Feldman and Newcomb, 1969; Astin, 1977; Pascarella, 1984, 1985).

Design

Of the original sample of 70 high school high school seniors, 47 attended college full-time during the 1986-1987 academic year, while 20 did not. (Three individuals attended college only part-time and were dropped from the sample.) Of these two groups subsamples of 30 college and 17 non-college subjects were matched as far as possible on the following variables:

ethnicity (caucasian vs non-caucasian); gender; 1986 Watson-Glaser CTA total score; ACT composite score; and family socioeconomic status. This was accomplished in two steps. First, 17 matched pairs of college and non-college subjects were chosen. Subsequently, 13 additional college subjects that came close to matching an existing pair were added to the sample. A multivariate analysis of variance indicated only chance differences between the college and non-college groups on each of these variables, as well as non-significant differences in secondary school grades and the five subscales of the CTA. These two matched subgroups were then followed up approximately one year later (May of 1987) with a second administration of the Watson-Glaser CTA. In addition to completing the CTA, the participants also completed a questionnaire instrument which asked about their specific experiences and involvements during the intervening year. (To maximize cooperation, participants in the follow-up were given a modest monetary incentive.) This provided for a pretest-posttest, quasi-experimental design in which comparison groups were generally matched on salient pretest variables (Campbell and Stanley, 1963).

To determine if the participants in the study differed significantly from those not participating, a multivariate analysis of variance was conducted on all variables collected in 1986. The results of this analysis were non-significant.

Approximately 85% of all follow-up testing on the CTA for each comparison group was carried-out individually. This occured in the subject's home, during visits to his or her campus or, in a few cases, his or her place of employment. The 15% of the testing for each group which could not be

conducted individually was conducted by mail. Subsequent to a phone call, participants were sent the CTA and questionnaire by first-class mail. Included was detailed set of written instructions for completing the CTA which were identical to those read to students completing the CTA individually. Participants were reminded both by the phone call and the mailed instructions to observe the time limits for completion of the CTA. A follow-up analysis indicated non-significant differences in CTA total and subscale scores between those participants in both comparison groups completing the follow-up either individually or by mail. Thus completing the CTA by mail did not appear to bias the scores of either the college or non-college groups.

Data Analysis

The basic data analytic approach was analysis of covariance (ANCOVA) solved by multiple regression. The dependent variables were Watson-Glaser CTA total score and each of the five subscale scores. The major independent variable was a dummy vector where 1 represented those high school seniors who attended college in 1986-1987, and 0 represented those matched seniors who did not attend college during the same period. The covariates in the analysis were appropriate 1986 CTA scores, ACT composite scores, secondary school grades, family socioeconomic status, and educational aspirations. The last variable was considered a salient covariate because a confounding influence present in quasi-experiments, even when comparison groups are matched on key pretest variables, is the interaction of selection and maturation. That is, the motivation underlying the choice of attending college (versus not doing so) may also have a significant effect on the outcome measure (in this case, critical thinking). To at least partially control for this possibility, the

influence of 1986 educational aspirations was statistically removed (along with the other covariates) from the relationship between college attendance and 1987 critical thinking scores. (Indeed, although the college and non-college group did not differ significantly on other 1986 covariates, they did differ significantly in educational aspirations.)

The regression analyses were solved in a hierarchical manner (Overall and Spiegel, 1969). The covariates were entered first, followed by the dummy variable representing the college/non-college groups, and finally a set of covariate X dummy variable cross-products. The last set of variables tested for covariate X college/non-college interactions. The absence of such interactions is one of the assumptions of the analysis of covariance model (Cohen and Cohen, 1975).

Results

Table 1 summarizes the regression ANCOVAs for total and subscale scores on the Watson-Claser CTA. Table 2 shows, by group, the means and standard deviations for all variables on the pretest and the covariate adjusted means and standard deviations of all posttest CTA scores. As Table 1 indicates, the five covariates explained 65.7% of the variance in 1987 CTA total score. Net of the covariates, the addition of the dummy variable representing college attendance (versus non-college) increased the explained variance (R^2) 3.6%, which was a significant increase at $p<.05$. (The addition of the set of covariate by college/non-college interaction terms was associated with a non-significant increase in explained variance.) As shown in Table 2, with the covariates taken into account, one year of college attendance was associated

with a 3.73 point advantage (over the matched non-college group) in 1987 CTA total score. Since the 1987 CTA standard deviation for the non-college group was 8.43, this represented an effect size of .44 of a standard deviation (3.73/8.43). Using the area under the normal curve, this translates into an advantage of 17.0%. Thus, net of the covariates considered, one year of college attendance provided a 17% improvement or advantage in overall critical thinking beyond that which beyond accrued to similar students who did not attend college during the same year.

Insert Tables 1 and 2 about here

As Table 1 further indicates, however, the positive influence of the freshman year on critical thinking was not the same for all subscales of the CTA. Net of the five covariates, college attendance had only a trivial, chance influence on the inference, recognition of assumptions, and deduction subscales of the CTA. On the interpretation and evaluation of arguments subscales, however, college attendance was associated with statistically significant R^2 increases, over and above the covariates, of 10.0% and 6.8%, respectively. Translated into effect sizes, this meant that the freshman year of college was associated with a 24.8% improvement or advantage in interpretation and an 17.7% advantage in evaluation of arguments beyond that which accrued to similar students not attending college.

As Table 1 further shows, the set of covariate X college/non-college interaction terms was associated with a non-significant R^2 increase in the prediction of all five subscales of the CTA. Additional analyses also found

no significant gender or ethnicity (caucasian/non-caucasian) X college/non-college interactions in the prediction of CTA total or subscale scores.

Additional Analyses

An additional set of analyses was conducted to determine the college experience variables which, net of the covariates, had significant associations with CTA scores. These college experience variables were collected from student responses on the follow-up questionnaire instruments completed by the college group in May 1987. They included the following:

1. college selectivity: the average SAT or ACT composite score of the freshman class;
2. living on-campus versus commuting to college (coded 1 = living on-campus, 0 = commuting to college);
3. average number of hours spent studying each week;
4. frequency of non-classroom discussions with faculty (of at least ten minutes duration, and on intellectual, academic, or controversial topics);
5. frequency of non-classroom discussions with other students (of at least ten minutes duration, and on intellectual, academic or controversial topics);
6. frequency with which the "editorial pages" of a newspaper were read (coded: 4 = "always"; 3 = "frequently"; 2 = "sometimes"; 1 = "seldom or never");
7. number of times one attended college-sponsored lectures/debates on intellectual, academic or controversial topics;

8. number of unassigned books read on intellectual, academic, or controversial topics;
9. number of university-sponsored extracurricular activities; and
10. number of science or logic courses taken during the freshman year.

Partial correlations controlling for the five covariates were computed between each of these ten variables and CTA total and subscale scores. Because of the small sample size for the college-only group (N=30) the significance level was set at $p<.10$. Even with this liberal alpha level, however, none of the partial correlations was significant beyond what would be expected by chance. Indeed the partial correlations were quite small and probably trivial (ranging from - .10 to .22). This suggests that no individual or specific college experience may be salient enough to discernibly influence the development of critical thinking.

Given this finding, it was reasoned that some measure of the student's total involvement in the college experience might reflect a more powerful or salient influence on critical thinking. To this end, a seven-item composite estimate of student involvement in college was constructed from the following individual experiences:

1. living on-campus (vs commuting)
2. hours spent studying
3. frequency of non-clasroom discussions with faculty
4. frequency of non-classroom discussions with peers
5. frequency of attendance at lectures/debates
6. amount of unassigned reading
7. extra-curricular involvement

Since the individual experiences were on a different metric they were standardized prior to summation. The composite scale had an alpha (internal consistency reliability) of .61.

Subsequently, partial correlations were computed between the overall college involvement estimate and the CTA total and subscale scores. The variables controlled statistically were the five covariates used in all previous analyses plus the student body selectivity of the institution attended. These analyses yielded partial correlations between overall college involvement and the CTA scores ranging from .20 to .43. Of these, four were statistically significant at $p<.10$ with 22 degrees of freedom. They were: CTA total score (partial $r = .34$); inference (partial $r = .35$); recognition (partial $r = .36$); and interpretation (partial $r = .43$). Additional analyses indicated that the magnitudes of these partial correlations did not differ significantly for students with different levels of precollege critical thinking, academic aptitude, family socioeconomic status, secondary school grades, or educational aspirations.

CONCLUSIONS

The vast majority of research on critical thinking during college has focused only on changes in college students. A literature review suggests that this may be the first longitudinal investigation which assesses the effects of college on the development of critical thinking by comparing matched groups of high school seniors who attend and who do not attend college. Consequently, within the limitations of the design and sample, the findings may provide one of the first estimates of the unique effects of the first year of college on critical thinking.

From one perspective, the findings are encouraging in that they suggest that the freshman year of college significantly enhances the critical thinking of individuals over and above the gains which could be typically expected had these same individuals decided not to attend college the first year after high school grduation. From another perspective, however, the findings are somewhat more sobering in that they suggest that the unique or net influence of the freshman year is modest: an estimated advantage of 17.0% in overall critical thinking; an advantage of 24.8% on the interpretation subscale; and an advantage of 17.7% on the evaluation of arguments subscale. On three of the five dimensions of critical thinking used in the study, inference, recognition of assumptions and deduction, the first year of college provided no statistically reliable advantage in development over that attained by similar students who did not attend college.

Such findings suggest that the freshman year of college has a modest, but discernible, positive influence on the development of critical thinking, and that this influence is selective. The net influence of the freshman year appears most pronounced in the enhancement of the student's capacity to weigh evidence, determine the validity of data based generalizations or conclusions, and distinguish between strong and weak arguments. In terms of one's ability to discriminate the truth or falsity of inferences, recognize assumptions, and determine if stated conclusions follow from the information provided, the net advantage of the first year of college is substantially less pronounced and perhaps trivial. The possible exception to this latter conclusion is the marginally significant ($p.<.15$), positive effect of college on deduction (determing if conclusions follow from data). A larger sample may have

provided the necessary statistical power to reject the null hypothesis on this subscale.

In terms of the modest magnitude of the effects of college on critical thinking, it is worth considering that the investigation encompasses only the first year of college. It is distinctly possible, that the cummulative effect of two or four years of college (versus no college) would be substantially greater. Recent research on other measures of development has suggested that students continue to make gains over the course of formal postsecondary education, while the growth curve of those who end their formal education with secondary school tends to plateau or flatten out (Rest and Thoma, 1985). Tempering this conclusion, however, is the finding of Lehmann (1963) that, while students had higher levels of critical thinking as seniors than as freshmen, the greatest gains occured during the freshman year. Determining the magnitude of the unique influence of college on critical thinking over a longer time period than was possible in the present study is an interesting, and potentially important, are for further research.

An additional aspect of the study sought to determine if the effects of the freshman year on critical thinking were the same for different kinds of students. This was determined by adding a series of variables to the analyses of covariance which were definded by the cross-products of individual student characteristics and the dummy variable representing college/non-college. These cross-products or interaction terms failed in all instances to significantly increase the explained variance in CTA scores over the main-effects. Such findings suggest that the effects of the freshman year on 1987 critical thinking found in this study were the same for students with

different levels (or categories) of initial (1986) critical thinking, academic aptitude, secondary school grades, family socioeconomic status, gender and race.

A final major finding of the study concerned those specific college experience variables which influenced or failed to influence critical thinking. Net of the covariates, the student body selectivity of the college attended had only trivial and non-significant partial correlations with any of the 1987 critical thinking scores. (The partial correlations ranged from -.08 to .10, and were generally the smallest of all partial associations observed.) This finding is quite consistent with previous research by Astin (1986) and Astin and Panos (1969) which suggests that, net of individual students' input abilities, the academic selectivity of a college's student body (along with other measures of "quality" such as library size and financial resources) has little incremental influence on student learning. It is also important to point out that the effects of college selectivity on 1987 critical thinking did not interact with any of the student precollege traits. Thus, the effects of college selectivity on critical thinking did not vary for students at different levels of academic aptitude, precollege critical thinking level, high school grades, educational aspirations or family socioeconomic status.

Similarly, it is noteworthy that other specific measures of the college experience such as curricular emphasis (number of science and logic courses) living on-campus, non-classroom interactions with faculty and peers, study time, amount of non-assigned reading, and extra-curricular involvement all failed to have significant partial associations with critical thinking, net of the study covariates. This finding perhaps suggests that critical thinking,

at least as measured by the Watson-Glaser Critical Thinking Appraisal, is a broad dimension of student intellectual development that is unlikely to be substantially influenced by any one specific college experience or curricular emphasis. As such, the findings are quite consistent with the conclusions of McMillan's (1986) review of research on the facilitation of critical thinking in college students.

This is not to say, however, that a student's level of intellectual and social/interpersonal involvement in college is not a potentially important influence on the development of critical thinking. Net of the study covariates, a composite measure of student intellectual and social intellecual and social involvement in college had significant, positive partial correlations with overall critical thinking as well as with a number of different dimensions of critical thinking. Such a finding has two implications. First, it directly supports Astin's (1984) theoretical proposition that the extent and quality of student involvement in college are the principal determinants of college impact on student development. Second, it suggests that, rather than any one particular experience, it is the student's total engagement in the intellectual and social experience of college which enhances the development of critical thinking ability. This reinforces the notion that intellectual or cognitive development in college may be the result of an integrated total experience rather than the outcome of involvement in specific isolated experiences. In terms of college influence on critical thinking, the whole may indeed be greater than the sum of its parts.

Limitations

This study is limited in a number of ways. Most obvious, perhaps, is the issue of design. Despite matching on salient precollege variables and the use of reasonably efficient statistical controls, individuals in the study could still choose to attend or not to attend college the first year after secondary school graduation. An attempt was made to control for a salient influence on one's motivation to attend college (i.e., education aspirations). Nevertheless, there may have other uncontrolled variables influencing one's propensity to attend college which were also associated with critical thinking. Thus, the interaction of selection and maturation is still a potential threat to the internal validity of the study.

In terms of external validity, the major threat is the small sample size and the fact that it was necessary to match students on salient precollege variables in order to obtain obtain reasonable group equivalence. Consequently, the results can only be generalized to non-college individuals similar to those who actually attend college. The rather small sample size also afforded the study limited statistical power. Thus, there may be potentially important college effects which could not be detected in the present sample.

Finally, the study is also limited by the fact that the comparison groups of college and non-college subjects were followed only over a single year (May 1986 - May 1987). This creates two possible limitations in the results of the study. First, the findings of the study reflect only the impact of the first year of college. As previously pointed out, investigating the net effects of college on critical thinking over a longer period of time is a research

direction worthy of serious consideration. Such studies, however, will probably require more comprehensive samples than those available in the present study. Although the educational aspirations of the non-college group were significantly lower than those of the college group, they nevertheless had a mean value only somewhat less than a B.A. degree. Furthermore, in follow-up interviews in May 1987, nearly 70 percent of the non-college group reported that they were likely to attend college the following year. Thus, after one year the naturally occuring control group of non-college subjects would no longer be a viable control group.

A second limitation stemming from the time period of the study is the fact that it included not only the first year of college, but also the May-August (1986) period prior to college enrollment. Seven of the 30 students in the college group took at least one or more formal college summer courses prior to formally enrolling in college in August or September of 1986. A subsequent analysis indicated only chance differences in 1987 CTA scores between these seven individuals and the 23 who didn't take college summer courses. Nevertheless, this time period may have permitted other non-college experiences which potentially confound the results of the study. To the extent that such activities are directed at preparing the individual for college enrollment, however, they might be legitimately considered as an impact of college.

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TABLE 1
Regression ANCOVA Summaries for Watson-Glaser CTA scores

	Total Score			Inference			Recognition of Assumptions			Deduction			Interpretation			Evaluation of Arguements		
Source	Var	df	F	Var	df	F	Var.	df	F	Var.	df	F	Var.	df	F	Var.	df	F
Covariates[a]	.657	5	15.69**	.752	5	24 92**	.512	5	8.61**	.400	5	5.46**	287	5	3.30*	.342	5	4.26**
Residual	(.343)	41		(.248)	41		(.488)	41		(.600)	41		(.713)	41		(.658)	41	
College/non-college	.036	1	4.69*	.001	1	0 08	.000	1	0.00	.038	1	2.78	100	1	6.51*	.068	1	4.63*
Residual	(.307)	40		(.247)	40		(.488)	40		(.562)	40		(.613)	40		(.590)	40	
Covariate x College/ non-college interactions	.032	5	0.82	.028	5	0.89	.108	5	0.98	.084	5	1.23	.071	5	0.92	.063	5	0.83
Residual	(.275)	35		(.219)	35		(.380)	35		(478)	35		(543)	35		(.527)	35	

[a]Covariates were: ACT composite scores; secondary school grades; family socioeconomic status; educational aspirations; and corresponding pretest CTA scores (i.e., 1986 total score in the prediction of 1987 total score, 1986 inference score in the prediction of 1987 inference score, etc.)

*p < .05

**p < .01

TABLE 2

1986 Means and Standard Deviations for all Variables and 1987 Adjusted Means and Standard Deviations for Watson-Glaser CTA Scores

Variable	1986 Non-College M	1986 Non-College SD	1986 College M	1986 College SD	1987 Non-College M (Adj.)	1987 Non-College SD	1987 College M (Adj.)	1987 College SD	Differences Between Adjusted Means
ACT Scores (aptitude)	25 06	3.59	25 23	3.21					
Secondary School Grades	5 06	1.25	5 10	1.35					
Family Socioeconomic Status	19.98	1.12	20.01	.96					
Educational Aspirations	2.47	.95	3.30	.75					
CTA Total Score	56 47	10.15	55.80	10.08	59.28	8.43	63.01	8.44	3.73[a]
Inference	11.47	2.85	11.52	2.99	12.21	2 11	12.32	2.40	.11[a]
Recognition of Assumptions	10.88	3.30	10.43	2.84	12.15	2.09	12.12	2.43	-.03[a]
Deduction	11 41	2 53	11.67	2.07	11 75	2 75	12.88	2.16	1.13[a]
Interpretation	11.35	1.69	11.20	2.68	11.46	2.06	12.90	1.90	1.44[a]
Evaluation of Arguments	11.36	2.98	11.03	1 94	11.63	2.57	12.83	1.83	1.20[a]

[a]College minus Non-College